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THE PROGRESS OF ELECTRICAL AND TELEGRAPHIC SCIENCE IN ENGLAND AND AMERICA.

THE remarks made by Mr. Latimer Clark at a recent meeting of the Society of Telegraph Engineers, to the effect that English telegraphists and electricians must make a push if they do not wish to be outstripped by their Transatlantic cousins, must have fallen somewhat unpleasantly on the ears of the large assembly present. Coming as the remarks did, from one so eminent in the profession as Mr. Clark, they should not be passed over unnoticed.

The assertion that English telegraphists and electricians are allowing themselves to be beaten by their American rivals, arose in consequence of the great stir and excitement that has been created by the successful working of the telephone and quadruplex telegraph system. But remarkable and ingenious as these two inventions are, we hardly think it fair that they should be allowed to completely throw into the shade the discoveries and enterprises which have their origin in this country, nor, we think, are they conclusive evidences of our backwardness in the general progress of telegraphic and electrical science throughout the world.

Every country achieves triumphs peculiar to itself, and because these triumphs do not produce immediate and startling results, it does not at all follow that they are the less worthy of being noticed, much less should they be ignored. The waters may run slow from being deep, but that is very different from their being stagnant.

We are very far from considering that the invention of the "telephone," is not one of the most remarkable inventions of human ingenuity that has ever been made; and we think that the many attempts which have been made, on the most flimsy grounds, to assign the credit of the conception of the idea to any other than Professor Bell, should be received with the contempt they deserve.

The attempted comparison of the present remarkable invention of Professor Bell, with the crop of "tone" telephones which have lately sprung into existence or have been resuscitated, is almost too absurd to be noticed. Sir William Thomson, recently most truly remarked that Professor Bell's telephone is as different from other telephones as a clap of the hand is different from the human voice, and we must confess that we are surprised that so much bad taste, to say the least, has been displayed in making such comparisons.

Although the telephone and quadruplex telegraph system reflect the very highest credit on their inventors, we think that the discovery by Dr. Kerr of the rotation of a beam of polarized light when reflected from the polished pole of a powerful electro-magnet, although it is not obviously a discovery of practical utility, it is still one which marks an epoch in the annals of the progress of electrical science, not in this country alone, but in the world, and is worthy of Faraday himself. The effect of light in altering the resistance of selenium is also surely not unworthy of notice; nor should the mathematical works of Sir William Thomson, Clerk Maxwell and others be forgotten, merely because they are beyond the comprehension of the mass of practical electricians and telegraphists and cannot therefore be appreciated by them.

It may be argued, however, that we have only spoken of purely electrical science, and that in practical telegraphy no progress has been made. English telegraphists have, however, no cause to be ashamed of themselves on this point. The network of ocean cables has been rapidly spreading, and is still spreading, and the whole of this is due to English enterprise and skill. The application of the duplex system to cables presents many points of difference from the ordinary duplex method employed on land lines, and this is due to English ingenuity.

The very complete systems of signalling by electricity on railways, which are so well described by Mr. Langdon in his new work, a notice of which will be found in our columns, certainly does not show that English telegraph engineers lack either ingenuity or energy. The application of electricity to railway working is, however, an almost unknown subject, except to those who have to deal directly with it. Occasionally, indeed, the daily papers incidentally refer to the "block system;" but although the immense traffic carried on over our metropolitan and suburban railways would be utterly impossible without the assistance of electric signalling, yet very few know the perfection to which the electric block system has been silently brought.

We have by no means exhausted the list of improvements and inventions in telegraphy which are due to English engineers, in the few isolated cases mentioned; the number is by no means small or unimportant, as could be made evident if necessary, but enough has been said to show that the palm should not as yet be yielded to any foreign rivals, however energetic and inventive they may be.

GAS LIGHTING BY ELECTRICITY.

THE recent increased adoption of a system of lighting street gas lamps by electricity in Providence, Rhode Island, shows that the general principle may be considered to be a success, and is likely to make further progress.

The system referred to, which has been described in the number of this Journal for July 15th, is worked by pneumatic and electric power, the former being employed to turn the gas on and off at the different lamps, and the latter for lighting the same. The method has, we understand, been applied to 220 lamps, in Providence, for some months past, and with perfect success, an annual saving of 40s. per lamp being effected by its agency.

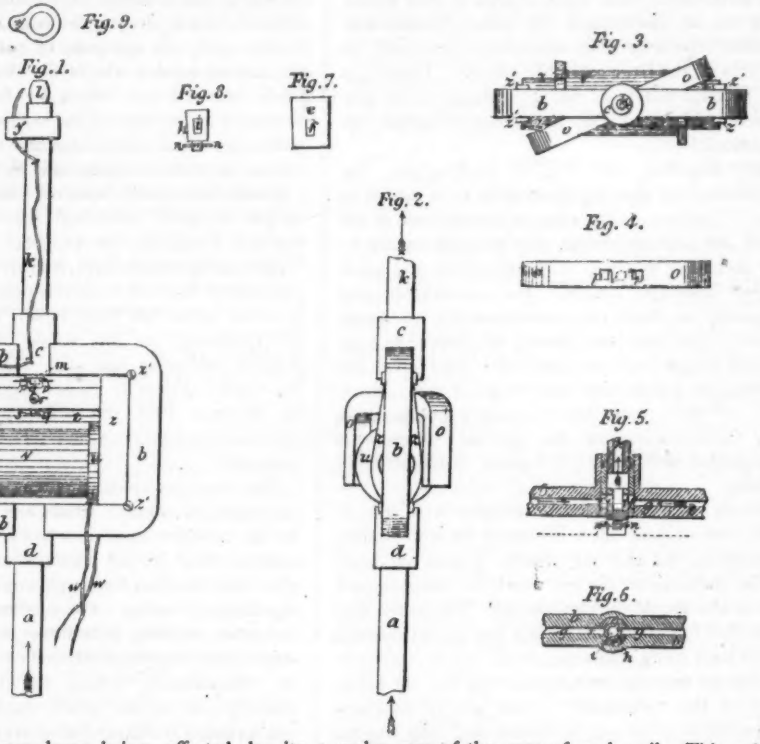
An highly ingenious invention for lighting by electricity, due to Mr. George Lane Fox, has been on trial at the Gas Light and Coke Company, at Fulham, and has been most successful.

Mr. Fox employs but one wire, passing from lamp to lamp, for accomplishing both the turning on and off of the gas and for lighting the same. The way in which this is effected is as follows :—

Each lamp is provided with a small induction coil of the ordinary make, without, however, a condenser, or a contact breaker. The primary wire of each coil is in the circuit of the line wire, so that a current sent through the latter traverses the primaries of all the coils of the set of lamps on a circuit. The arrangement in fact is similar to that adopted by M. Jablockhoff for dividing the electric light.

The secondary wire of each coil has one end connected to the pipe, and the other brought in close proximity to the burner of each lamp, so that if the gas were turned on at each, and a powerful momentary current were sent along the line, and consequently through all the primaries, induced currents would be set up in all the secondaries, and these currents would make themselves manifest in the form of sparks jumping from the end of the wires on to the burners, and the gas at each lamp would thereby be lighted.

To turn the gas on and off at each lamp, Mr. Fox



makes use of the core of each coil. This, when magnetized by a current of moderate strength, causes a permanent magnet attached to a stop-cock of peculiar construction to be rotated on an axis, and thereby to turn the gas on. If the current be reversed, the movement of the permanent magnet is reversed, and the gas is then turned off.

The action of the apparatus is as follows :—When the lamps are to be lit, a positive current, say, from a few cells of any kind of battery, is sent through the line ; this magnetizes the iron cores of each of the induction coils, and the permanent magnet being thereby rotated, the gas is turned on. A momentary powerful positive current is now sent through the line ; this sets up the induced currents

in the secondaries, and the sparks from them light the gas. To turn out the gas, the current from the small battery is sent in the reverse direction to what it was in the first instance, and the permanent magnets being caused to rotate in the reverse direction to what they were at first, the gas is turned off.

To produce the powerful momentary current for producing the sparks, Mr. Fox employs a very large condenser, charged up by an ordinary inductorium. This condenser being discharged through the line, gives sufficient power to induce the necessary quantity of current in all the secondaries to produce the sparks.

Figs. 1, 2, 3, 4, 5, 6, 7 and 8 show the different parts of the apparatus attached to the lamp.

Fig. 1 is a front elevation, fig. 2 a side elevation, and fig. 3 a plan of the apparatus; fig. 4 is a plan of the permanent magnet; figs. 5 to 9 represent details to be referred to.

a is the gas pipe leading from any ordinary source of supply; *b b* is a rectangular frame of white metal or brass, cast or made with a hollow core, and having two cylindrical portions, *c d*. The part *d* is screwed upon the gas-pipe *a*, which supports the apparatus, and the part *c* receives the stop-cock; this cock, which is shown in sectional elevation in fig. 5, and in sectional plan in fig. 6, is composed of a brass tube *e* (shown separately in fig. 7), which fits into the cylindrical part *c*, and has two openings, *f f*, corresponding with the passages *g g*, in the opposite sides of the frame *b b*; *h* is the plug of the cock (shown separately in fig. 8); it is made with a very slight downward taper, and has two apertures or ways *i i*, corresponding with the openings *f f* in the tube *e*, and it is hollowed out in the middle. When the gas is turned on, the apertures *i i*, come opposite the openings *f f*, the gas having then a free passage from the pipe *a* through the two sides of the frame *b b*, and into and through the plug *h*. It will be seen on reference to fig. 6, that a small turn of the plug is sufficient to open or close the cock. *k* is a pipe screwed into the tube *e*, and leading to the burner *l*. *m* is a projection at the lower end of the plug, and *n* is a pin passed through the same. The plug is supported on the point of the pivot on which a magnet turns, so that very little power is required to turn the plug. *o* is a permanent magnet, which may be either cast in steel, with the two projecting pieces *p p*, or made out of a steel bar bent into the proper shape, and in this case the projections *p p* are produced by screwing in two pieces of metal. *q* is the pivot on which this magnet turns; it is passed through a vertical hole in the magnet, and fixed by a screw *r*. The lower end of the pivot rests in a steel step *s*, which is supported by a small wooden beam *t*, secured to the ends of the wooden bobbin *u*. *v* is the induction coil; it is composed of a core of soft iron wires, two layers of primary wires wound with covered copper wire of about No. 20 BWG, and upon these about 10 to 15 layers of secondary wire of about No. 40 BWG. The primary wires *w w*, form part of the circuit by which the lamps to be lighted or extinguished simultaneously are connected. One end of the secondary coil is connected to an insulated wire *x*, leading to the burner *l*, where it terminates in a platinum point, and the other end is connected to the frame *b*, or to any other metallic part of the apparatus, so as to be in metallic connection with the burner. The insulated wire *x*, passes through an earthenware support *y* (seen in plan in fig. 9), fixed to the pipe *k*. The soft iron core projects about three-eighths of an inch from each end of the wooden bobbin *u*. The bobbin is fastened to wooden supports *z z*, which are fixed to the frame *b*, by screws z^1 z^1.

The whole of the apparatus attached to each lamp does not occupy a greater space than 2½ in. high by 2½ in. wide. It is screwed on to the supply pipe in the lamp, and the line wires are carried down the interior of the lamp-posts and laid underground, unless, of course, an open wire is employed.

The system was introduced by Mr. Fox at the Fulham Station about eight months ago, and has been applied to about 40 lamps scattered about the premises, and with the greatest success.

Should the trial, which we understand will be carried on throughout the winter months, be successful, the chances of its partial adoption, at least, are very favourable.

We are inclined to think that the automatic stop-cocks will be found to stick when exposed to a sharp frost, from the oil congealing, even though the oil of bitter almonds is employed; but this is a possible defect which we are sure Mr. Fox's ingenuity will be able to overcome, if necessary. The saving which would be effected by adopting the system is estimated at £1 per lamp per annum, and we do not think that this is is an excessive estimate.

We wish Mr. Fox every success.

A SKETCH OF THE DEVELOPMENT OF THE ELECTRIC LIGHT.

By J. MUNRO, C.E.

THE electric light was first discovered by Sir Humphry Davy. Soon after the invention of the voltaic pile, Davy had a large voltaic battery of two thousand pairs constructed, and with this new and powerful engine of research, made several successful inroads on the secrets of nature, achieving his crowning discovery of the alkaline metals, the decomposition of water into its component gases, and evoking the first rays of what promises to become a source of illumination rivalling the sun at noon—the so-called electric light. Attaching one day the poles of his battery to two small pieces or "points" of carbon, and approaching them together in order to see the "spark" pass, he was somewhat astonished to create a beam of pure white light, which almost dazzled him by its matchless brilliance. He observed that to procure the light it was necessary to approach the carbon points very near, almost in contact, but on drawing them apart again the light still continued, and assumed the form of a luminous arch which he called the "voltaic arc." He could establish the light when the points were one-twenty-fifth of an inch apart, and maintain it when they were separated by a space of four inches.

There was intense heat in the luminous arc. The most refractory substances when inserted into it become incandescent. Platinum melted like the wax of a candle; gold, silver, copper, disappeared

in vapour; sapphire, magnesia, lime, diamond, were instantly fused. But the most remarkable feature of the light was its startling brilliance; it bore a striking resemblance to the light of the sun itself. If the heating effects were greater than any otherwise produced on earth, so were the illuminating effects. The iridescent radiance of the source, the pure argent of its beams, the deep black shadows which it cast, the noon-day purity of the tints, which even the most delicate colours displayed when seen by it, and the fact that it excited phosphorescence in bodies susceptible of it, all conspired to heighten its likeness to solar light. Brande showed that it combined chlorine and hydrogen like sunlight; it produced daguerreotypes, and was not polarized. Wollaston found that the spectrum of the new light resembled that of solar light, but differed from it and other spectra by the presence of certain bright lines, which Sir Charles Wheatstone afterwards found to be due to the physical nature of the electrodes or "points" from which the light proceeded, and the gas or other medium in which the arc was formed. The spectrum of the voltaic arc was also found to be similar to the spectrum of the ordinary electric sparks under similar conditions.

The general form and appearance of the "voltaic arc" are well known. The ends of the two carbon points are seen to be glowing at a white heat. Based upon the points, and extending between them, is an arc of intense white light, almost cylindrical in form. This is enclosed in a more spheroidal envelope of rarer luminous matter, whose colour changes with the nature of the electrodes and the medium, and gives the bright lines to the spectrum. The arc is slightly convex upwards like a bridge; and probably so, because of the ascending tendency of heated air. There is a notable transference of particles of the carbon from the positive electrode or point in connection with the copper pole of the battery, towards the negative electrode or point in connection with the zinc pole. This transference goes on in a constant stream along with the current; the surface of the positive carbon is gradually eaten away, and the transferred particles are deposited on the negative carbon. Thus, while one point is hollowed out and wasted, the other grows by aggregation of the abstracted material. The violent energy of the current tears down the molecular structures of one carbon and piles up the ruins on the other. It raises this stream of carbon dust to the state of incandescent vapour, yielding an intense white light. In the central cylinder of the arc a powerful flow of electricity and white-hot carbon particles is going on. The heating of the carbon in the first place is due to its being a bad conductor; the vigorous resistance which it offers to the energy of the current developing a great heat. With carbon electrodes there is, of course, some combustion of the electrodes in air resulting in flame; but this does not affect the intensity of the light, which is due to the incandescence of the carbon particles by the current, and is as brilliant in vacuo as in air. The light is lasting because, unlike the instantaneous spark from a Leyden jar, the voltaic current is continuous.

When electrodes of other material than pure carbon are used, the transference of particles still takes place in the form of incandescent vapours, which tinge the colour of the arc. The electrodes of higher resistance become the more intensely heated; thus, platinum electrodes would become more highly heated than silver ones. Matteucci found that a layer of non-conducting material, such as a film of oxide between the points, caused them to be raised to a higher temperature by the current. Some of the tints given to the light by metal electrodes are very beautiful. Mercury, silver, and thallium, give a refreshing green; gold, a brilliant yellow; platinum gives a white; and zinc, a blue light.

Davy found that the arc was quite as vivid in a vacuum as in air, and that it could be obtained of nearly double the length. He found that, although there could be no combustion of the carbon, the heat was also quite as great as in air. Platinum wire held in the arc melted in brilliant scintillations, and fell in globules to the bottom of the exhausted bell-jar. The tint of the light is white in vacuo as in air; but it varies with the medium as with electrodes. In oxygen it is white, in hydrogen it is crimson. In oxygen, it is less brilliant, in nitrogen it is more brilliant than in air. Davy also obtained the arc in liquids, for example, oil, water, acids, ethers. In a liquid it is formed of the central cylinder only, and is not so bright as in a gas or vacuum.

The spheroidal form of the luminous arc has been attributed to the mutual repulsion of the electrified air and carbon particles, compounded with the attractions of the opposite poles upon them. Some physicists have thought that it reveals a column of the ether set in a state of vibration by the passage of the current, but we are uncertain as to the true explanation of it. After Oersted's discovery of the mutual action of magnets and wires conveying electric currents, Arago surmised that the voltaic arc would be attracted by a magnet. Davy found the surmise correct. The arc of luminous vapour along which the current was flowing between carbon points, was attracted or repelled with a rotatory movement according to the position of the poles of the magnet, and the direction of the current. By a powerful electromagnet it was possible to pull the arc into an acute angular shape, and even to destroy its equilibrium, and break it up altogether. The sudden change is accompanied by a sharp detonation like mimic thunder.

Further experience of this promising illuminator served to lay bare its practical defects. It was found to be unsteady, flickering, and unreliable. The wasting of one carbon point, and accretion of the other, changed the relative positions of the points and diverted the position of the arc, causing it to play to and fro, and flicker. Sometimes the arc was bridged over by filaments of the transferred carbon built up by the current; but more generally the space between the carbons grew so wide by the consumption of the carbon points that the current failed to span it, and the arc became extinguished. These difficulties with the electrodes were merely mechanical, and could be in course of time overcome, as they ultimately were in an admirable manner, by the regulators of Dubosq and Serrin. But a more serious difficulty appeared in the inconstancy of the action of the voltaic batteries employed in generating the current. The chemica

solutions supplied to the cells tended to work themselves out, the cells to get foul, and, as a consequence, the current to get weaker. This was a failing beyond a merely mechanical remedy; it required a chemical one, which is far more difficult to find. Large batteries, too, necessary for the light, were very expensive—it took a hundred Daniell cells or eighty Bunsen cells to produce a good light. In the face of these latter obstructions a new avenue of progress disclosed itself in Faraday's discovery of magneto-electric induction. Although the voltaic light by means of regulators was rendered very useful in magnifying objects for lecture purposes, it was a failure in the lighting of buildings and lighthouses until the magneto-electric machines, which sprung from Faraday's discovery, supplied an abundant and perfectly reliable source of the current.

In the month of November, 1831, Faraday discovered magneto-electric induction, or the *induction* of electric currents by magnetism. He took a welded ring of soft bar iron, nearly an inch in thickness and some six inches in diameter. Round each half he coiled a separate helix of copper wire. The different turns of wire were insulated from each other, and the whole were insulated rom the iron "core" by layers of twine. These two helices were separated from one another at each extremity by about half-an-inch of the uncovered ring; they were also sewn up in calico. Fig. 1 represents this ring with its two helices A and B, and the wires which form them. Faraday connected the helix B in circuit with a galvanometer and then passed the current from a voltaic battery through the helix A. At the first instant of "making" the battery contact and allowing the current to traverse A, the needle of the galvanometer in circuit with the helix B was powerfully deflected, thus indicating the instantaneous passage of a current through B in an opposite direction to the current through A. After this instantaneous effect had subsided, the needle came back to, and remained perfectly steady at its old zero position, although the battery current still circulated in the helix A. On "breaking" contact, however, with the battery, so as to stop the current in A, the needle was again deflected, but in the contrary direction to that at first, that is to say, in the same direction as the current had been flowing through A. The more powerful the current sent through A the greater was the corresponding effect in B. "Upon using the power of one hundred pairs of plates with this ring, the impulse at the galvanometer when contact was completed or broken was so great as to make the needle spin rapidly round four or five times before the air and terrestrial magnetism could reduce its motion to mere oscillation. By using charcoal at the ends of B helix, a minute *spark* could be perceived when the contact of the battery with A was completed. This spark could not be due to any divergence of a part of the current of the battery through the iron to the helix B; for when the battery contact was continued, the galvanometer still resumed its perfectly indifferent state. The spark was rarely seen on breaking contact. A small platina wire could not be ignited by this induced current; but there seems every reason to believe that the effect would be obtained by using a stronger original current or a more powerful arrangement of helices."* Faraday had previously obtained similar results with wood and glass for the "core" of the helices instead of iron; but the effect with iron was much more powerful. He saw that the gain in power was ued to electro-magnetism generated in the iron core by the current. In the case of the glass or wooden core the current was generated by what he had called *volta-electric induction*; it was purely a current effect. But Faraday saw that it was, at least in part, a magnetic effect in the case of the iron core, and his next step was to dispense with the voltaic current altogether, and to produce the like effects by means of ordinary magnets. He found that if a magnet were suddenly thrust into a hollow helix in circuit with a galvanometer a momentary current was induced in the helix, and that when the magnet was withdrawn again an opposite current was induced. He found on winding the soft iron armature of a magnet with a helix of wire in circuit with the line, that the mere approach of the armature to the poles of a magnet induced a current in the helix and deflected the needle; while, on withdrawing the armature again,

Fig. 1.

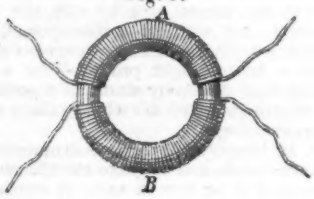


Fig. 2.

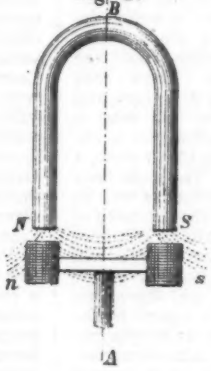
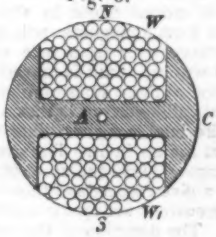


Fig. 3.



* Faraday's Experimental Researches.

a reverse effect was produced. It was only necessary that there should be a certain relative motion between the coil and the magnet. One or other must move relatively to the other in a particular way. When they were stationary with regard to each other there was no current generated. Thus after approaching the armature to the poles, the deflection on the galvanometer ceased—there was no current in the helix; but, on withdrawing it, a current was again set up in a reverse direction.

Faraday worked skilfully to find out the laws of this magneto-electric induction which he had discovered. First, he observed that in the case of the coiled armature, the current set up in the coil or helix was such a current as would itself have produced in the armature a magnetic polarity opposite to that which had been produced in it by contact with the poles of the magnet, that is to say, in a direction calculated to oppose the magnetism induced in the armature by contact. Further researches made clear the simple condition of magneto-electric induction, namely, that it is only necessary that the wire or *conductor* should be made to *cut* the "lines of magnetic force" in a "magnetic field," for an induced current to be set up in it. The magnetic space in the neighbourhood of a magnet is the "magnetic field"; the "lines of magnetic force" are the imaginary lines or directions in which the magnetic forces in the field act, they are the lines along which a small magnetic needle would set itself if moved about in the field. These lines radiate from a magnetic pole in all directions, and they curve over from pole to pole. If, then, a closed wire or circuit is moved at right angles to the direction of these lines of force so as to cut them, a current will be set up in that wire. The more lines the wire cuts in a given time, the stronger will be current set up in it. The greater the intensity of the magnetic field the more of these lines will there be in a given space, and therefore the stronger will be the current set up for a given movement of the wire. The direction of the current will depend on the direction of the movement with regard to the poles of the magnet. The following is a simple rule for remembering the direction of an induced current. It is well known that the earth is a great magnet with north and south poles and lines of force running north and south, through the atmosphere, between them. If, then, we suppose a wire to rise upwards through the atmosphere from the earth, so as to cut these lines of force, an induced current will tend to be set up in the wire in the same direction as the motion of the sun, namely, from east to west. If the motion of the wire were downwards to the earth, the direction of the induced current would be, of course, reversed. If the wire formed a *closed circuit*, and was spun round a horizontal axis so that each half cut the lines downwards and upwards, alternately each revolution, a pulsatory current would be set up in the wire, which would be at its maximum strength when the circuit was perpendicular to the lines of force, and at zero strength when the circuit was parallel to them.

The first attempts of Faraday to get chemical effects from the magneto-electric currents induced by permanent magnets failed in spite of his strictest precautions; he could neither feel the tickling sensation on the tongue, caused by the electric current, nor was he able to convulse frogs' limbs, nor to ignite charcoal, or fine platinum wire. But further experiments at the Royal Institution with the armed loadstone, or natural magnet of Professor Daniell, enabled him to convulse a frog very energetically each time magnetic contact was made, and the more instantaneous the contact the greater was the effect. He also thought he felt the sharp sensation on the tongue with the attendant flash before the eyes, of an electric shock; and he concluded that by means of more powerful magnets, and chemical action, the ignition of metal wires and carbon, could be also effected. In January of the following year (1832), Signor Nobili, of Florence, announced that he had succeeded in getting a *spark* by means of a permanent magnet. In March, Professor Forbes of Edinburgh also elicited one, by means of the powerful natural magnet of Dr. Hooper, presented to the University of Edinburgh. Faraday foresaw these results, and the important practical consequences likely to flow from them in the future. "I have rather, however," he says, "been desirous of discovering new facts, and new relations, dependent on magneto-electric induction, than of exalting the force of those already obtained; being assured that the latter would find their full development hereafter." His words have been abundantly verified. Magneto-electric machines have been developed to types of almost perfect fitness; and their powerful currents made to produce electric lights of almost solar splendour. Visitors to the South Kensington Loan Exhibition of Scientific Apparatus, last year, were able to see, almost side by side, the rough calico-covered ring with its carbon points, from which Faraday drew the first tiny magneto-electric spark, and a beacon light produced by a large Gramme machine driven by steam, of a power and brilliancy that illuminated the whole gallery with a clearness resembling day.

In 1831, M. Hippolyte Pixii, an instrument maker of Paris, invented the first magneto-electric machine, and the germ of those now in use. It consisted of a permanent magnet placed horizontally, and an armature surrounded by a helix of wire. The magnet was rotated in front of the armature, which remained stationary. It furnished a continuous succession of sparks, which gave strong shocks, charged Leyden jars, and decomposed water. In order to get the sparks, the circuit of the armature was interrupted by an arrangement of metal points, once every revolution.

Pixii's apparatus was next improved by Saxton, who first exhibited his form at the British Association meeting at Cambridge in 1833. It differed from Pixii's in two important respects. The armature revolved and the horizontal magnet remained stationary. The interruptions of the circuit were produced by points, carried by the rotating axle, and dipping into a pool of mercury with which they broke contact at each revolution. In 1835, Saxton substituted two armatures for the one which had been previously employed. One armature was wound with a helix or bobbin of long, fine wire; this gave *intensity* currents which produced powerful shocks, and chemical decomposition. The other was wound with a bobbin of short, stout wire, and yielded *quantity* currents of plentiful heating effect. Such an arrangement is shown in fig. 2, where N S is the permanent magnet, and *n s* are the two armatures rotated by the axle A. The

lines of magnetic force are shown by dotted lines proceeding from the poles N and S. As the bobbins revolve round the axis A B, each of them is carried in front of the poles N S in turn, cutting the lines of force radiating from each pole perpendicularly. The induction current is then at its height. As the bobbins leave the poles they cut the lines of force more obliquely, and when they are midway between the poles they are moving almost parallel to the lines of force, which curve over from pole to pole. The induction current is here at its least. To secure the most powerful effect then, the circuit of each bobbin was interrupted when it was cutting the lines of force in front of each pole. As each bobbin passed both poles in one revolution, the currents generated in it were alternately of opposite kind. But by suppressing the current generated by the passage of any one particular pole, Saxton could get a succession of similar currents from each bobbin. The use of a commutator for reversing the alternate currents, so as to make them concur in the same direction, does not appear to have occurred to him. It was added in 1836 by Mr. E. M. Clarke, who describes his improvements in the *Philosophical Magazine* for October of that year. Clarke also placed the magnet vertically, whereby vibrations, known to be injurious to magnets, were greatly avoided in the working of the machine. The current from these and the other similar machines of the time were nearly, but not quite, continuous, however fast the armature might be rotated.

In 1841, Wheatstone patented a plan for combining several of the existing machines so as to produce a continuous current. He arranged the several armatures on one axle, and connected them in one continuous circuit, each coil of the series rotating in its own magnetic field between the magnets in such a way that the induced current should commence in one before that in the one immediately before it had ceased. The current was carried off from each coil by a pair of springs bearing on the axle and making contact with the ends of the coil when it was undergoing its maximum induction. He compared such a machine to a voltaic battery of a great number of small elements, and called it a magneto-electric battery.

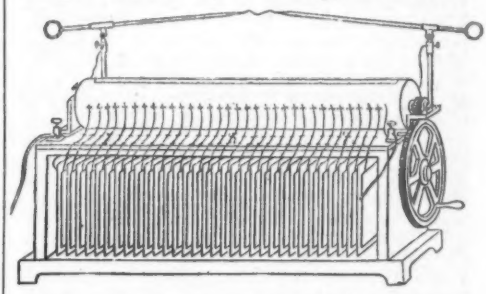
After this, various combinations of a number of coils and magnets for the production of continuous currents became common. In 1856, an important improvement in the construction of the armature was invented by Siemens and Halske. Instead of winding the wire round the core, as in a reel or bobbin, Siemens wound it longitudinally along the core in the direction of the axis of rotation. Fig. 3 is a cross section of this arrangement, A representing the axis of rotation which was vertical; C being the iron core, originally cylindrical, but scooped out along opposite sides to form beds for the wire, and left rail-shaped; W W' are cross sections of the wire; N and S represent the positions of the poles of the permanent magnet or magnets, which might be hollowed out so as to enclose the armature as closely as possible, in order to concentrate the inductive effect. The principal advantage of Siemens' armature over the old bobbin forms lay in the fact that more of the wire was made to cut the lines of force at the proper instant. In an ordinary cylindrical bobbin something like half of the wire would be parallel to the lines of force while the other half was cutting them at right angles; but in Siemens' armature only the short lengths of wire which crossed the ends of the armature from one side to the other—that is to say, from W to W'—would be parallel to the lines of force between N and S, while the long lengths parallel with the axis of rotation would cut the lines of force perpendicularly. At each revolution of Siemens' armature two opposite currents are generated in the coil in succession, but by means of a commutator all the currents in one direction can be diverted into one wire or electrode, and all the currents in the other direction into another electrode, these two electrodes becoming the poles of the magneto-electric generator. Another advantage was that the rotation of the armature round *its own axis* diminished the resistance of the air to the revolution of the armature.

(*To be continued.*)

A NEW RHEOSTATIC MACHINE.

By M. GASTON PLANTÉ.

IT is known that Franklin made use of a series of Leyden jars, arranged in "cascade," to obtain powerful discharges of static electricity; that, on the other hand, Volta, Ritter, Cruikshank, &c., charged condensers from a battery, and that their



results gave rise to researches, either by calculation or experiment, on the part of a great number of physicists.

I, in my turn, was led to study the static effects of voltaic electricity, with the aid of a secondary battery of 800 pairs, which I have in use at present, and I have devised an apparatus which shows the intensity to which these effects may attain.

Having seen how easily a condenser, with a sufficiently thin insulating plate of glass, mica, gutta-percha, paraffin, &c., could be charged with this battery, I united a number of condensers, formed preferably of mica and tin-foil, and I arranged them like the pairs of the secondary battery itself, so that I could charge them in "quantity," and discharge them in "tension."

All the pieces of apparatus employed have, of course, to be carefully insulated. The commutator is formed of a long cylinder of hardened caoutchouc, furnished with longitudinal metallic bands intended to connect the condensing surfaces, and traversed at the same by copper wires knee-shaped

at their ends, with the object of connecting the condensers for tension. Springs made of wires or strips of metal are connected to the terminals of the condensers, and fixed on a plate of ebonite at either side of the revolving cyliner.

If the two extremities of the apparatus are connected with the secondary battery of 800 pairs, even several days after charging with two Bunsen cells, and the commutator is rotated, there is obtained between the two pointers in which the extreme condensers terminate, a series of sparks in every respect similar to those given by electrical machines furnished with condensers. Employing an apparatus composed of only thirty condensers of 3 square decimetres each, I have obtained sparks 4 centimetres in length.

It is not necessary to employ a secondary battery of 800 pairs to produce marked effects with this apparatus. With only 200 pairs, sparks of 8 millimetres are obtained; and it would, no doubt, be possible by still further diminishing the thickness of the insulating plates, and augmenting the number of condensers to obtain similar effects with electricity of lower tension.

It is worthy of remark that the discharges of static electricity, given by this machine, are not alternatively positive and negative, but always in the same direction, and that the loss of power resulting from the transformation must be less than in induction machines; for, the voltaic circuit being never for one instant closed, there is no conversion of any portion of the current into heat. The apparatus can be kept in rotation a long time, producing a considerable number of discharges, without the secondary battery appearing sensibly weakened. This follows from the fact that each discharge carries off but a very small quantity of electricity, and that, as has been said, the battery circuit is never closed by a conductor. The electricity from the battery is simply spread over polarizing surfaces offered by all the condensers so often as they are discharged. But this constantly repeated emission necessarily carries off a certain quantity of electricity; and when the apparatus is charged from a secondary battery, it is possible after a time to exhaust the limited quantity of electricity furnished by the battery current. We thus see, by a method apart from induction, properly so called, and by a simple effect of static induction incessantly repeated, the transformation into dynamic electricity; so that the apparatus above described may fairly be called *rheostatic.—La Nature.*

ON THE DECOMPOSITION OF ORGANIC LIQUIDS BY THE ELECTRIC SPARK.

By M. P. TRUCHOT.

(Extract from "Journal de Pharmacie et de Chimie," October, 1877.)

IN studying the works of M. Berthelot on the formation of carbides of hydrogen, I was struck with the conclusion at which, among others, the eminent chemist arrived—namely, that in the pyrogenous decomposition of organic substances "a first analysis, almost conclusive, tends to bring the original principles to the state of the four fundamental carbides—acetylene $(C_2 H)_2$, ethylene $(C_2 H_2)_2$, methyl $(C_2 H_3)_2$, and formene $C_2 H_4$, which immediately recombine to form by synthesis the whole system of pyrogenous carbides."

I have endeavoured to give a new experimental demonstration to this interesting fact by producing fundamental carbides under such conditions that they could not recombine immediately after their formation.

With the aid of an induction coil a series of electric sparks is passed through the interior of a liquid organic substance, such as a carbide of hydrogen, ether, &c., by means of the following arrangement.

A tubulated glass globe containing the liquid is closed by a cork pierced with three holes. Through two of these holes are passed capillary glass tubes carrying platinum wires for the purpose of producing the spark within the body of the liquid; the third receives a short tube to carry off the gases. When sparks pass, gas is disengaged, more or less abundant according to the nature of the liquid employed; this is collected over mercury, and each bubble of gas rises through the liquid, being driven off by the heat produced by the spark; thus, if the fundamental carbides are produced, these conditions present a recombination, just as in the case of a mixture of gas or vapour passed through a red-hot tube.

There is, however, a precaution to be observed. As the gases produced by this dissociation of the liquid might be dissolved in the latter, and be then subjected to the action of the spark, the liquid is warmed to a temperature approaching its boiling point. On the other hand, that there may not be too much vapour mingled with the gases produced, a wash-bottle is inserted in the carrying-off tube, cooled down as much as may be necessary, for the purpose of condensing the vapour. The liquid collected in the wash-bottle is itself warmed at the close of the operation so as to extract therefrom any gas which may have been dissolved in it.

The more volatile liquids, such as amyl hydride $C_{10} H_{12}$, amylene $C_{10} H_{10}$, ether $C_8 H_{10} O_2$, give a sufficiently large quantity of gas, one litre per hour for example. The more fixed liquids give less. The gaseous mixtures obtained have been analysed by the methods long known and recently re-employed by M. Berthelot. The vapour of the liquid under examination is collected by absorbents either at the end of the process or during its progress.

In every case examined I have obtained acetylene $(C_2 H)_2$ or $C_4 H_2$, ethylene $(C_2 H_2)_2$ or $C_4 H_4$, formene $C_2 H_4$, and hydrogen, without any other carbides more condensed—that is, containing more than four equivalents of carbon. The formene was probably mixed with a certain quantity of ethyl hydride (methyl) $(C_2 H_3)_2$ or $C_4 H_6$, the fourth fundamental carbide of M. Berthelot. I do not, however, affirm this, although I have reason to believe it, judging from analyses based upon the employment of absolute alcohol as an absorbent. I hope to return to this point and decide the question when working with larger quantities of gas.

The formic carbides (extracts of the petroleums), which are saturated carbides, give no deposit of carbon during the decomposition, if care is taken to warm the liquid, as has been said. Amylene gives

a small trace of carbon. But the carbides which are far from being saturated, such as essence of turpentine, and, above all, the benzinic carbides—benzine and toluene—produce, as might have been expected, a deposit of carbon, in addition to the fundamental carbides. Oxygenated substances like alcohol, ether, the allehydes, give no trace of carbon; but, besides the simple carbides, carbonic oxides is obtained, without carbonic acid or water vapour.

A number of questions present themselves at the end of these trials, some of which I hope to resolve shortly.

Review.

The Application of Electricity to Railway Working. By WILLIAM EDWARD LANGDON. (London: Macmillan & Co.)

A SHARPLY defined gap in electrical and telegraphic literature is well filled by the above work, which deals in an able and comprehensive manner with one branch of telegraphy, that has within the last few years almost developed into a special profession of itself. All railway travellers, a term which now is a synonym for the general public, hear more or less of the block system, as the means by which their safety is secured, and the punctuality and regularity of trains, and freedom from accident are evolved from the apparent chaos of a busy railway system; and many know that electricity is the moving agent by which this result is achieved, but beyond this, few but specialists have any acquaintance with the extended adaptations of electricity to railway working. A perusal of this book will demonstrate what a field electricity has developed for itself in this direction. It is, in fact, assuming more and more a position, analagous to that of the nervous force in the economy of mankind; directing and controlling all movements, transmitting intelligence to the guiding powers, and instructions from them to the moving agents of the system, and generally rendering a proper supervision of the whole possible. The author, however, whilst dealing at large with all the electrical appliances, does not confine himself to a mere description of apparatus, but deals exhaustively with the rules and regulations under which they should be used, so that his book becomes a *vade mecum* for railway men generally in the subject of working traffic.

In commencing, Mr. Langdon very properly avoiding the not uncommon error of attempting to condense in a few opening pages a treatise on electricity, leaves the tyro to refer to any of the numerous electrical works for his theories, and after giving an introductory chapter of terms and definitions, plunges at once into his subect.

The first division deals with speaking instruments, and it describes clearly and distinctly the apparatus generally used for message purposes on railways. It then deals lucidly with the regulations which should be adopted in all railway telegraph offices, regulations the importance of which can only be fully appreciated by experienced railway men, and the neglect of which has led to more than one serious accident, as many will call to mind. Next comes a chapter on the important subject of single line working, and crossing of trains, and lastly one on general supervision, and the arrangements of circuits.

The question of working single lines, without delay, and with safety, is one of very great importance, and one that can only be solved in practice by careful organization and strict discipline; and the best system for obtaining the desired result is fully dwelt on by the author.

The second and largest division takes up the important question of block signalling, and commencing with an historical sketch, showing how the instruments used for block working have gradually been evolved from the first needle instrument used on the Blackwall Railway in 1840, to the present perfect forms; he describes at length, and with the aid of numerous diagrams, all the modern apparatus used on large railways, including Walker's, Spagnolleti's, Siemen's, and also Preece's two systems. Next the general theory of, and full instructions for, block working are given; and this subject forms a not unimportant part of the work, for it is very properly pointed out that a block system is quite independent of the form of instrument by which its working becomes possible; that some instruments possess many electrical and other advantages over others, but that the regulation by which the block is maintained, does not really give any distinctive characteristic to the block system of one company as compared with that of another. A good instrument adopted by a railway company, if worked under an imperfect set of regulations, might lead to disaster, whilst a comparatively imperfect instrument, under perfect regulations might for a long period conduct a traffic safely. It is, of course, however, desirable that the best form of apparatus should be employed in all cases; and the conditions to be fulfilled by a good block instrument are fully detailed.

A careful consideration of these regulations and of the requirements of a block signalling instrument which the author's extended experience has led him to embody, and a comparison of these with the previous descriptions of the block apparatus of various inventors, will readily lead the critical readers to an opinion as to the best form for practical work.

We must confess that Preece's three wire system appears to conform more closely to the conditions laid down by our author than any other of the apparatus described, although many of them exhibit considerable ingenuity in the adaptation of their parts to the special purposes in view.

A chapter on automatic block signals, details some ingenious arrangements for working signals by the aid of electricity, direct from the motion of a train itself. If these could be safely adopted they would undoubtedly lead to a considerable economy in the working expenses of a line. Railway companies in England have, however, fought rather shy of automatic signals, and they certainly have scarcely reached the state of perfection in which it may be said that they accord with the principles laid down at the end of the chapter, as those which should govern automatic signalling.

The second division of the work is completed by a chapter on junction and siding working, with a description of the junction interlocking switch, and of the precautions to be observed at these points.

The third division deals with miscellaneous applications of electricity, amongst other, signal repeaters, the working of movable bridges, intercommunication in trains, &c., &c., for particulars of which we must refer our readers to the work itself.

We may, however, glance at two of the chapters, those dealing with repeaters with intercommunication in trains.

It has no longer become necessary to impress on railway managers the urgent necessity for using signal repeaters, as this has been fully recognized by all important and advanced railway administrations. The chapter on this subject describes the various forms of apparatus in general use, and will be found to lay the matter clearly before the reader.

Lastly on the question of inter-communication in trains, a subject, by the way, which meets with more support from the public than from railway managers, the methods of achieving the object in view, by means of electricity, are fully described. Preece's and Walker's systems, which are the only electrical ones that have survived, are fully dealt with. There appears to be little doubt that if the present useless and inefficient cord system is to be replaced by an efficient communication, we must look to electricity for the means, as no purely mechanical arrangement can be made to adapt itself readily to the varied requirements of a complicated train service.

The work throughout is well illustrated, all the descriptions of apparatus are carefully prepared, and the action of each portion traced. The book should find a place in the library of every telegraph engineer and electrician, and no officer of any railway company, either superintendent, station master, or clerk, should be without a copy. The careful reading of such a work must tend to put life into the dry bones of printed official instructions, by pointing out clearly to all concerned, the *raison d'être*, and consequently the necessity for the rules laid down for their guidance.

In doing this it will be conferring a great boon on the travelling public, for most accidents arise from neglect of instructions, the need of which is not often clearly seen, but the neglect of which becomes at times fatal.

The book evinces great care in preparation and lengthened experience in railway working, and deserves a full measure of success.

Notes.

THE irrepressible Mr. Proctor, whose facile pen discourses in a dozen different periodicals at once, from the *Nineteenth Century* down to the *Echo*, and on themes which range from the evolution of the universe to the manufacture of soap, has again been expounding telegraphic matters. This time his happy theme is the reported invention of Mr. Edison, for graphically recording speech. We have already called attention to Mr. Proctor's sanguine prediction that ere long we shall be whispering secrets to each other under the Atlantic bed, by means of the telephone; whispers which a single one of the waves which "toss in millions" on the Irish coast would hopelessly drown. It is interesting, of course, to hear about the Irish waves, but professional electricians, at least, are more anxious to know how the whispers would escape being "drowned" by induction. Can Mr. Proctor enlighten them on this point? The problem cannot be more difficult than the crystallising of sound, the next achievement in science which Mr. Proctor holds out to us. In an article on the "New and Wonderful Phonograph," in a public newspaper, that pen-and-ink discoverer and scientific seer informs us that "just as words may be crystallised by this process and reproduced when desired, so may music, or, indeed, any sounds." We must here guard against misconceiving a bold figure of speech, for an actual fact (although we must say the writer does not help us much in the distinction); but if the statement is to be taken in earnest, we should like to know whether music would crystallise into sugar candy, and if "popular science" would not take the form of "frost ferns on a window pane." But perhaps we ought, rather, to feel grateful to Mr. Proctor, for his apparently boundless faith in the electrical profession. He is ready to believe all things of electricity. We feel sure that if any new American genius should announce to the world that he had resuscitated the ashes of his grandmother by means of electricity, he would have a warm friend and believer in Mr. Proctor, who would at once pen an article to the *Echo*, explaining the process, and disclosing the affecting intelligence that in a few months we should all have our grandmothers back again, and that we need not be surprised any day to see Adam and Eve walking down the Strand together.

WE understand that Dr. Muirhead and Mr. Herbert Taylor, C.E., have successfully established the duplex balance on the Direct United States Cable at Ballinskelligs Bay by means of Muirhead's artificial line. It only remains now to set up the balance at the American end of the cable, and we believe that Dr. Muirhead will shortly proceed there for that purpose.

AT a recent meeting of the Cambridge Philosophical Society, Professor Clerk Maxwell gave an interesting account of the unpublished writings and researches of Henry Cavendish, who, he said, had in his time a wide and penetrating knowledge of electricity, and a great deal of electrical apparatus, including condensers. Cavendish had a correct conception of the idea "potential," which is a fact to be wondered at, seeing that very few nowadays can be said to have the same.

THE electric light has been recently tried with every success at the works of Messrs. Edmund and Co., Dublin.

A company has been formed at San Francisco, under the directorship of Mr. Leland Stamford, president of the Central Pacific Company, for the purpose of laying a cable between California and Japan *via* Honolulu,

Sandwich Islands. It is called the Trans-Pacific Cable Company, and the capital stock is 10,000,000 dollars.

SOURING OF MILK IN THUNDERSTORMS.—Dr. Malvern Iles, of Baltimore, has proved by experiment that the souring of milk during thunderstorms is due to the action of ozone formed by lightning discharges. The ozone forms lactic and probably acetic acid in the milk, while the caseine curdles out. Dr. Iles filled a eudiometer tube with fresh milk and pure oxygen then passed a succession of sparks from a Rhumkorff coil through the oxygen to form ozone, causing the milk to become sour and curdled.

DILATATION OF WIRES BY THE ELECTRIC CURRENT.—It has been thought that the electric current dilates the wire through which it is passing to a greater degree than that due to its heating effect, and results have been obtained supporting the idea. Recent experiments of M. Exner, however, on wires of platinum, copper, iron, and steel, lead him to believe no such dilatation exists. The experiments were made by heating the wires to a steady temperature by the current, and measuring both the dilatation and resistance. By means of the resistance results it was possible to raise the wires afterwards to exactly the same temperature by means of an ordinary source of heat. A comparison of the dilatation when heated by current and when heated otherwise, showed no extra dilatation due to the current.

M. MAICHE has put forth the theory, to which experiments have conducted him, that water is hydrogen with the addition of electricity, or oxygen lacking electricity. In other words, he considers water, hydrogen, and oxygen, to be the same substance under different degrees of electrification.

ELECTRIC DISCHARGES THROUGH RARIFIED GASES.—The experiments of M. Eugen Goldstein, Berlin, recently translated by Dr. Schuster, lead their author to conclude that no distinction can be made between "positive" and "negative" electric lights in rarified gases; nor is it probable, as was supposed, that the positive discharge is analagous to metallic or electrolytic conduction. Positive and negative lights are essentially the same, and it is possible to convert them into each other through a continuous series of intermediate phases. M. Goldstein was able by suitable experimental arrangements to give to the positive discharge all the properties supposed to belong exclusively to the negative discharge, with the sole exception of the peculiar stratification of the negative light. These properties are colour, spectrum, behaviour in the magnetic field, power of producing fluorescence, &c. For interesting details we refer readers to Dr. Schuster's translation in the *Philosophical Magazine* for November.

ELECTROLYSIS WITH DISENGAGEMENT OF HYDROGEN AT BOTH POLES.—A strip of magnesium plunged into very dilute sulphuric acid causes a very feeble disengagement of hydrogen, but when it is connected to a platinum wire, also plunged in the liquid, the disengagement of hydrogen becomes much more marked, and takes place at the platinum also; at the same time the magnesium becomes covered with a fine black coating which disappears when the connection between the magnesium and platinum is broken. Instead of connecting these two metals directly, the same effect can be produced by inserting a battery between the two metals, the magnesium being in contact with the positive pole. The result is the same, hydrogen is discharged at both poles, one volume at the positive pole, and two volumes at the negative pole. The dilute sulphuric acid may be replaced by a dilute solution of sulphate of magnesium, or a saturated solution of sulphate of potassium; in these cases magnesia is separated at both poles, but the quantity of it is much less than the loss of weight sustained by the magnesium strip, so that a part of the magnesia produced, remains dissolved under the form of a basic or double salt. If a saturated solution of sulphate of magnesium is employed, the metallic strip is dissolved quite rapidly without the current, and hydrogen is set free; the current accelerates the phenomenon, however, and nearly equal volumes of hydrogen are disengaged at both poles.—*Deutsche Chemische Gesellschaft.*

THE above researches were recently made by M. E. Elsaesser; but it appears that similar results had previously been obtained by M. W. Beetz, in 1866. M. Beetz is of opinion that the simple agreement of the volumes of hydrogen found by M. Elsaesser is fortuitous; that agreement changing with the concentration of the solutions employed.

ELECTRO-CHEMICAL ACTION OF AN ALUMINUM ANODE.—M. Beetz has found that when water, acidulated with sulphuric acid, is decomposed by means of an anode of aluminum, a portion of the oxygen combines to form alumina which is dissolved, while another portion forms a coating of oxide upon the wire, and a third portion is disengaged in the gaseous form. The sum of these quantities of oxygen is always too small. Experiments made with the acid diluted in the proportion of 1 to 12, and with an aluminum anode, and a platinum cathode in a voltameter, have given losses of 10, 1, 8, and 5 per cent. With a feeble current, a very gentle disengagement of gas, and wires of aluminum, if the intensity of current and surface of the anode be increased at the same time, the loss becomes less and less until, with ten Bunsen coils, it becomes nothing. In the first case, the small bubbles are absorbed by the liquid, and diffused into the air; in the second case, the warming up of the liquid and the rapidity of the gaseous current forbids absorption of the gas, and the ordinary conditions of electrolysis ensue.

LOSS OF WEIGHT IN A TELEGRAPH WIRE DUE TO TERRESTRIAL MAGNETISM.—It was seen by Faraday in

1821, that a wire with a current flowing in it from east to west, ought to gain weight under the action of terrestrial magnetism since such a wire may be considered part of a helix, which according to Ampere's theory, would be magnetic, and of a pole opposite to the earth's north magnetic pole. The hypothetical earth currents which could produce the earth's magnetism must flow from the east to west, and consequently a parallel current from east to west in the wire would be attracted by them. Similarly, a west to east current would be repelled by the earth, and hence the wire would appear to lose weight. In small magnets and helices this *attractive* effect of the earth's magnetism is only noticeable as a directive effect, owing to the small distance between the poles of the magnet as compared with the poles of the earth; but with a wire placed east and west the case is different. Faraday failed to obtain the result he sought owing to a new effect which he observed to take place at the mercury contacts by which he passed the current into the wire helix he employed. This helix was suspended from a delicate balance, and Faraday wished to note the rise of the balance due to the lightening of the helix when the current was sent through it. But on the mercury in the contact cups floated some dilute sulphuric acid, and when the current passed the surface of the mercury moved in such a way as to disturb the result—a phenomena which Faraday contented himself with merely pointing out, but which appears to have been a prior observation of the effect so well utilised since by Lippman. Professor I. W. Mallet, F.R.S., of the University of Virginia, has successfully performed the experiment in question with the results which Faraday foresaw from theory. Mr. Mallet weighed a number of wires together, each three metres long, while the current was passing through them, and in every case there was a lightening of the wires due to the repulsion by the earth's magnetism when the current passed from west to east, and a weightening of the wires when the current passed from east to west. When the current was passed from north to south, and or from south to north, there was a slight loss of weight in both cases. The amount of the effect depends, of course, on the place of the wire on the earth's surface.

MOTIONS OF CAMPHOR IN WATER.—It was observed by several physicists that small pieces of camphor flung into water moved about in a curious gyratory manner, and Dutrochet called the motive influence "epipolic" force. When lycopodium is sprinkled on the water, and the carbon held still, it is seen that the motion is determined by small currents of dissolved camphor setting out unequally from the sides of the camphor. The motion can be explained electrically on the supposition that electrified camphor particles in the water repelled the solid piece. Mr. Cassamajor, an American chemist, has recently found that other substances besides camphor, such as butyrate of soda, or potash, benzoic and succinic acids, carbolic acid, and citric acid, possess this property, and even pieces of cork soaked in ether will exhibit it. The motions do not always take place, although the apparent conditions are the same; for instance, they are likeliest to occur after sunset, in bright weather, or in a storm, rather than in cloudy, damp weather without a storm. A glass rod electrified with flannel, when plunged into the water, stops the motions of the camphor at once, when a vulcanite rod electrified with flannel, fails to stop, or even increases the motions. When stopped by the glass rod, however, the camphor can at once be set in motion again by touching the water with the vulcanite one. If the glass rod is repeatedly excited and dipped into the water, the stopped camphor begins to gyrate again, increasing its gyrations every time the rod is dipped in. These motions due to positive electricity may in turn be stopped by dipping in the vulcanite rod, but if the excited rod is repeatedly dipped the camphor will start into motion again. In passing from one kind of electrification to the opposite, separate pieces of camphor on the water coalesce, but separate when the water is uniformly electrified again. Mr. Cassamajor does not explain the cause of his observed results, but they appear to be due to the states of electrification existing between the water and camphor, repulsion ensuing when the water acquires the same kind of electrification as the camphor. Volta did not believe these motions to be due to electricity.

ON Dec. 5th telegrams were received in London announcing the total wreck of the steamship *Hibernia*, of the Telegraph Construction and Maintenance Company, in the bay of Maranham, Brazil, on the 22nd of November. All hands on board were fortunately saved. The *Hibernia* recently left the Thames with a cargo of cable to repair the Para-Pernambuco section of the Western and Brazilian Company's cables, and to lay shore ends into the intermediate port of Maranham. The details of the wreck are not forthcoming at present, but it is stated that it took place a few hours after she came to anchor in the bay. Up till November 29th, some sixteen miles of cable had been saved, but it was extremely doubtful whether it would be possible to save more. The cable, however, is fully insured, and we understand that steps will be taken to replace it as soon as possible. The *Hibernia* was a screw steamer of over 3,000 gross tons, and classed AA 1. She was built at Jarrow in 1861, by Messrs. Palmer and Co. Her dimensions are: length, 360 ft.; breadth, 40 ft.; depth of hold, 29 ft. The news was brought from Maranham to Pernambuco by the s.s. *Norseman*, the repairing ship of the Western Brazilian Company. The *Norseman* herself met with a mishap on her passage there. On Dec. 3rd, at 9.30 p.m., when off Cape San Roque, on the Brazilian Coast, she came into collision with the ship *Quintero*, of Valparaiso, presumed to have been on a voyage from the West Coast of South America to Boston, U.S. The *Quintero* sank half-an-hour after contact, but her crew, with the exception of one man,

were saved. The *Norseman* sustained no injury whatever by the collision.

IN consequence of the large numbers who were unable to obtain admission to the recent lecture at the Society of Arts on the "telephone," Professor Bell, at the special request of the Council of the Society, has consented to repeat his lecture on Wednesday the 19th inst. As there is certain to be a large attendance it is suggested that those members who heard the first lecture should refrain from exercising their privilege of being present on the second occasion.

No patent having been secured in Germany for the articulating telephones, they are being manufactured there in large numbers. Messrs. Siemens and Halske, of Berlin, have one hundred men exclusively engaged making them, and we hear they are being freely distributed as Christmas presents. The Russians are also using these instruments in field-telegraphing in the present Russo-Turkish War.

A CONTRACT has been recently signed between the Post Office authorities and the proprietors of Professor Bell's telephone, by which the latter is adopted as part of the telegraph system of the United Kingdom.

SEPARATION OF IRON ORE BY MAGNETISM.—In order to separate iron ore from its associated metals, Mr. King, of the Ballycorus Mines, Isle of Man, first crushes the crude ore, which is composed of galena, blende, and spathose iron ore, then separates the galena and roasts the residue to a dull red heat in revolving retorts, so as to produce magnetic oxide of iron by decomposing the spathic or carbonate. The ore is then put into drum wheels fitted inside with magnets, which attract and retain the magnetic oxide, while the blende is allowed to escape clear.

TRAFFIC RECEIPTS.

1877.	Anglo-American Co.	Brazilian Sub. Co.	Cuba Sub. Co.	Direct Spanish Co.	Direct U.S. Co.	Eastern Co.	Eastern Ex. Co.	Gt. Northern Co.	Indo-Euro. Co.	Mediterranean Ex. Co.	Submarine Co.	West Coast America Co.	Western and Brazilian Co.	West India Co.
	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.
JAN. ...	37,780	11,469	2,311	983	13,530	42,580	24,147	12,663	... ...	... ...	9,668	2,533*b*	10,100	4,058
FEB. ...	32,330	11,606	2,214	784	15,520	35,050	19,645	12,800	... ...	... ...	8,624	2,980*c*	11,026	3,870
MARCH ...	18,880	11,258	3,025	913	8,110	35,491	22,886	16,115	... ...	... ...	9,915	3,128*d*	11,643	5,854
APRIL ...	18,980	11,539	4,706	1,011	6,930	39,861	23,068	16,151	... ...	... ...	11,324	2,362*e*	10,295	7,729
MAY ...	45,420	12,251	4,109	997	17,370	46,309	25,445	18,427	... ...	... ...	11,048	2,179*f*	10,534	7,508
JUNE ...	40,040	9,742	3,295	887	15,260	45,477	24,126	19,663	... ...	... ...	9,960	4,025*g* / 2,225*h*	10,522	5,541
JULY ...	38,790	9,226	2,959	834	14,820	42,713	22,224	19,187	... ...	... ...	9,943	1,925	7,881	4,980
AUGUST...	41,170	9,407	2,728	804	15,700	40,428	25,371	17,998	... ...	... ...	9,683	2,025	8,610	4,201
SEPT. ...	43,230	9,253	2,466	836	15,940	35,440	22,113	18,445	... ...	... ...	10,029	1,625	9,504	3,802
OCT. ...	49,510	11,260	*3,000	945	13,486	37,402	21,388	21,210	... ...	... ...	10,823	2,225	10,037	*5,647
NOV. ...	47,890	12,096	*2,700	918	12,920	38,439	20,794	18,206	... ...	... ...	9,817	1,800	[12,941	*4,342

* Estimated. *b*, four weeks ending 13th January. *c*, four weeks ending 13th February. *d*, four weeks ending 10th March. *e*, four weeks ending 7th April. *f*, four weeks ending 5th May. *g*, four weeks ending 2nd June. *h*, four weeks ending 30th June.

City Notes.

Old Broad Street, Dec. 14th, 1877.

PEOPLE are thinking more of the approaching Christmas just now than of telegraph securities. Until after the holidays there will probably be nothing of special importance transpiring. No reliable news has reached England respecting the intentions of the American Government towards the Direct Cable Company. Some of Mr. Pender's friends continue to assert that there can be no interference on the part of the United States Government, while it is said, on the opposite side, that if the Government has not made up its mind to eat its own message it must take some decided action. We shall readily admit, if Mr. Pender's predictions be verified, that the instructions telegraphed to the ambassador were a piece of folly worthy of a child rather than of the government of a great nation. Mr. Pender, as we intimated in our last, has himself

relapsed into silence. But then he has been busy with other matters, and the affairs of the Direct Company do not absorb the interest they once did.

The loss of the *Hibernia*, with the cable intended to replace the broken cable between Para, Maranham, and Pernambuco, is a serious disappointment to the shareholders and directors of the Western and Brazilian Telegraph Company. The meeting of the company is being held as we go to press, but the disaster will, of course, be referred to by Mr. Rawson. It appears that the *Hibernia* was totally wrecked in Maranham Bay on the 22nd of last month, a few hours after coming to anchor. The cable was not wholly lost, sixteen miles of it being reputed as recovered up to Nov. 29, but the chances of getting much more are said to be very doubtful. The *Norseman* seems to have had a narrow escape also. If she had been wrecked, too, people would have began to fancy there was a fatality attaching to telegraph ships. It is understood that both the *Hibernia* and the cable were fully insured, and if that be so, no loss will be sustained either by the Telegraph Construction and Maintenance Company or by the Western and Brazilian. The closing paragraph of Mr. Abbott's newly-published circular may, no doubt, be accepted as a convincing proof with regard to the former. Mr. Abbott does not, indeed, seem to see any cause for commiseration: "Happily no lives were lost, and so far from the company suffering damage, they will simply have to commence work on another cable." We ourselves cannot help deeply regretting the occurrence. Such incidents have a bad effect upon the public, or, at any rate, upon the ignorant public, who will insist upon pointing to the wreck of a telegraph ship as a proof of the difficulties which beset the path of the pioneers of ocean telegraphy. We therefore await with some anxiety full particulars of the casualty. The directors of both companies will, we trust, be content with nothing less than the most straightforward details. If there has been any carelessness on the part of any one, let us know; whereas, if the accident was not preventible, it is equally desirable that the fact should be established.

Respecting the report of the Western and Brazilian Company, which ought to have been out long before now, we can scarcely congratulate the shareholders. It is true that the directors point, with what appears to read like a gloomy air of triumph—if such a state of thing can be imagined,—to the circumstance that "the result of the Company's working for the year is satisfactory in comparison with that of 1876." But following upon this sentence comes the cautious averment: "It is only, however, from a general revival of business that any material improvement in the traffic may be expected."

The "satisfactory conclusion" of the repairs of the Para-Pernambuco section, and the connection of these ports with Maranham, is now almost indefinitely postponed, and the attention of the Board will be diverted from the consideration of providing communication between North and South America, *via* the lines of the Central American Telegraph Company, to the enforced delay in the fulfilment of the contract, on account of which, it is stated in the report, £45,000 has already been paid to the Telegraph Construction Company. There is one thing to be said for the Western and Brazilian directors. They appear to pay their officers in South America liberally. No less than £16,468 stands to the debit of "salaries and wages" at the American stations. This is a large sum, but in such a climate as Brazil it probably is the reverse of excessive. The accounts are, we note, carefully audited, and Mr. Weire's example in appending an explanation of some of the items might be copied with advantage by some other auditors. We are afraid the Company will have to wait a considerable time before it can provide for "any loss on the shares."

The Brazilian Submarine Telegraph Company have declared an *interim* dividend of two shillings and sixpence per share, being at the rate of 5 per cent. per annum for the quarter ending September 30th. The dividend is payable on the 24th instant.

Sir Edward Watkin has ceased to be a director of the Great Eastern Railway Company. We are not much surprised. We never expected he could, single-handed, work a revolution at the Great Eastern Board. But we think he has made a mistake in retiring from the arena of conflict so soon. His election was celebrated with a tremendous flourish of trumpets, and a great many people went out of their way to further it. Recent events seem to indicate that Sir Edward is in the habit of changing his mind rather frequently.

By the way, Sir Edward is still chairman of the South Eastern Company. The little breach amongst the directors is not, as some may imagine, healed; the fire is only smouldering. There will be a flare-up, and in the end, we rather expect to see the two Watkins no longer on friendly terms with the South Eastern Company. But that issue too, is uncertain. Sir Edward may change his mind and frowns may give place to smiles.

The City editor of the leading daily newspaper did a deal of mischief to the Metropolitan Inner Circle scheme, and on one occasion it was reported that the enterprise was abandoned. But it will, as we have said before, be carried out. Even Mr. Crump has not maintained that the public will not benefit by it. We, who have always had considerable faith in the wisdom of the District Board, believe that, ultimately, the Inner Circle Company will pay a dividend.

A very interesting article appears in a weekly contemporary on the subject of second-class railway traffic. Our contemporary, having given some apparently very carefully prepared statistics, goes on to debate the question whether the leading railway companies will, or will not, eventually abolish second-class traffic altogether; and it is evident that the writer inclines to the opinion that second-class traffic might well be abolished. We do not think so. The Midland Company has scarcely proved that its experiment was successful. It is open to argue that its receipts would have been greater than they have been, instead of less, if second-class carriages had been continued. The Midland Company prospers because it is managed wisely and liberally, not be-cause it has only first and third-class carriages attached to its engines. We confess we should be of the two more astonished to see the other companies do away with second-class traffic, than we should to see the Midland adopt it again. Both are, perhaps, improbable.

Proceedings of Societies.

PHYSICAL SOCIETY.—1ST DECEMBER, 1877.

The President, Prof. G. C. FOSTER, in the Chair.

PROF. GRAHAM BELL exhibited and described the telephone before a crowded meeting of the society, prefacing his account of the apparatus, now so well known, by a very complete historical sketch of the progress of electric telephony. The first experiments referred to were those of Prof. Page, who, in 1837, was studying the relation of electricity to magnetism, and found that if a coil of wire, traversed by a current, surrounds an iron rod, a sound like a pistol shot proceeds from this latter whenever the current is made or

broken. He was followed by De la Rive, Poggerdorff, Reiss, and others; but Reiss was the first to employ the human voice in his experiments. After pointing out that, in transmitting sounds by electrical means, the initial sounds themselves are in no sense transmitted, but are only employed to generate currents which reproduce similar sounds, Prof. Bell proceeded to examine the phenomena which take place when sounds are transmitted through the air. It is, of course, not the motion of the vocal organs themselves that is received in the ear, but that of the air set in motion by their means, and all peculiarities in the sound must be peculiarities in the motion of that air. If the rapidity of motion varies it occasions a variation in the pitch, and the loudness is changed by changing the amplitude. The *shape* of the vibration produces timbre. If by moving the air in certain specified ways, certain vowel sounds are given out, then those same sounds will be emitted if an identical movement be occasioned by any mechanical means whatever, and Prof. Bell has found that such a motion may really be given to the air in various ways. Three classes of electrical currents have been employed for transmitting sounds to a distance, and these he denominates intermittent, pulsatory, and undulatory. The first form is obtained when a current passes for a brief interval, is then followed by an interval during which no current passes, and this by a current of the same or opposite sign. In the second class a current is continually passing but its intensity increases and decreases instantaneously; and finally, in the third class, this variation takes place gradually, and may, therefore, be represented by a sinuous line. In his experiments on the nature of the movement of the air, Prof. Bell employed a human ear, a hay style attached to the incus recording the movement communicated to it on a moving sheet of smoked glass. A very interesting series of curves, produced by this means, was shown upon the screen, and he explained how his experiments in this direction led him to the present form of telephone. Since the very small membrane of the ear was capable of setting in motion comparatively large bones, it seemed probable that it could cause a light piece of iron to vibrate. In the earlier form of apparatus, a piece of steel spring was therefore attached to a stretched membrane of gold-beaters' skin and placed in front of the pole of the magnet; but he found on increasing the area of metal that the action of the instrument was improved, and thus was led to do away with the membrane itself. Another branch of the investigation referred to the strength of the magnet employed, and this was modified by varying the strength of current. The battery was gradually reduced from 50 cells to none at all, and still the effects were observed, but in a much less marked degree; the action was in this latter case doubtless due to residual magnetism, hence in the present form of apparatus a permanent magnet is employed. Lastly, the effect of varying the dimensions of the coil of wire was studied when it was found that the sounds became louder as its length was diminished; a certain length was, however, ultimately reached, beyond which no improvement was effected, and it was found to be only necessary to enclose one end of the magnet in the coil of wire. A number of diagrams were projected on to the screen which showed the various forms the apparatus has taken from the time of Page to the present day. An air sung in a distant part of the building was distinctly heard in the room, by the aid of an improved form of Reiss' telephone, lent by Prof. Barrett, and made by Mr. Yates, of Dublin. Prof. Bell, Prof. Foster, and Dr. Gladstone then carried on a conversation with a gentleman at a distance, and utterances were shown to be audible when the transmitting instrument was held about a foot from the mouth.

A discussion then followed in which Mr. De la Rue, Dr. Gladstone, Profs. Foster, Guthrie, Atkinson, and others took part. In replying to the various questions, Prof. Bell stated that his attempts to determine the amplitude of the vibrations had not been successful, and he is coming to the conclusion that the movement must be molecular. Very distinct sounds are emitted when a considerable mass of iron is employed, and further, if the iron be glued to a piece of wood an inch thick, and this be interposed between it and the magnet, the action still continues. Conversation has been carried on through a distance of 258 miles, but a resistance of 60,000 ohms has been interposed without preventing the action. There is a very marked difference in the manner in which letters are reproduced by the telephone. Vowel sounds are more acceptable than consonants, and, as a rule, those letters are best transmitted which involve a large oral aperture in their utterance. Finally, he finds that high sounds are produced more fully than low ones, but this question has not yet received sufficient attention.

General Science Columns.

[By adding these columns on "General Science" to the TELEGRAPHIC JOURNAL, we hope to increase its usefulness. Some of the discoveries and inventions we shall have to chronicle will be found to have a more or less direct bearing on telegraphy, and others, although wholly unconnected with it, will perhaps be none the less interesting, especially to our numerous subscribers abroad whose other sources for such information may be scanty. The columns will contain the leading scientific advances which take place as time goes on. Gentlemen willing to contribute original articles to them are requested to communicate by letter with the "Manager," TELEGRAPHIC JOURNAL, 10, Paternoster Row, E.C.]

THE COMING PARIS EXHIBITION.—The buildings for the forthcoming Grand International Exposition at Paris are already in a forward state, notwithstanding the very short time which has been at the disposal of the executive committee. The holding of an exhibition in 1878, was first proposed by M. J. B. Krantz, honorary member of *Ponts et Chausés*, early in 1876. Decrees authorising its formation were issued in April by the foreign governments invited to contribute the necessary sum voted for expenses, and M. Krantz was created director by August of that year. Under his enterprising leadership, the site was fixed, the plans were got ready, and the works actually begun by the end of September. The works are in the hands of several contractors and are to be finished by March 1st, 1878. With the exception of Germany, all European states have signified their intention to contribute to the show; America, North and South, the North African Mussulman states, and the various empires of the East, Persia, China, Japan, Siam, Burmah, &c., are to be represented. All the available space has been applied for, the English section being the largest, and the exhibition promises to be a great success.

The site has been happily chosen, both in regard to space and artistic effect. It occupies ground on opposite sides of the Seine; on the south side a portion of

the Champ de Mars, and on the north side the elevated ground known as the Trocadéro, which Napoleon III, transformed from a piece of waste quarry-land into a pleasure garden. There will be a exhibition building on each of these spaces, and the "pont d' Jena" will form the connecting bridge across the river. About 700,000 square yards of ground have been enclosed for the purposes of the exhibition, the greater portion being on the Champ de Mars side where the main exhibition building stands. The two buildings are parallel to each other, the central axis of one cutting that of the other across the river. That in the Champ de Mars is a temporary erection of iron and glass and designed exclusively for the exhibition; whereas, that in the Trocadéro is a permanent stone building and is intended to be a theatre, concert hall, and museum for the people, in short a Parisian Crystal Palace.

The Champ de Mars building is the largest yet built for exhibition purposes, being 2,315 feet long and 1,145 feet wide. Its greatest length is perpendicular to the river like that of the ground itself. It is in the form of a hollow rectangle, each of the longer sides being composed of a pair of lofty naves, and each of the ends consisting of a series of four transepts or vestibules. The naves are 2,200 feet long and will afford magnificent vistas, several hundred feet longer than the nave of the Crystal Palace at Sydenham. The interior of this hollow rectangle will be laid out as a garden, but will contain two separate buildings to be devoted to the Fine Arts, as well as several detached pavilions for other small subordinate collections.

The outer transepts are set apart for machinery, and are made very spacious to allow of its being shewn in operation. The rest of the transepts and naves will be devoted to industrial products and scientific apparatus; one set of transepts being reserved for France, the other set being distributed amongst other nations.

The entrances of the building will open into these transepts. Covered promenades will run round both the inner and outer walls of the building like a piazza. Since a portion of the quays on both sides of the river will be closed to traffic while the exhibition lasts, underground tunnels or subways have been driven along the river banks for the convenience of passengers.

The building in the Trocadéro or Palais du Trocadéro as it is called, is a good specimen of French architectural genius, at once exquisite in detail and daring in design. Standing on the summit of a small hill, it occupies a commanding position and overlooks a considerable extent of the city. In general shape it resembles a very flat horseshoe, or semi-ellipse, and consists of a great central hall flanked by two curving wings, the whole being situated in an ornamental garden. The central hall or rotunda is domed, the wings are decorated with minarets, and the stonework is barred like the mosques of Cairo, so that the whole structure has quite an Oriental appearance. The great hall is fitted with seats and tiers of boxes capable of accommodating 7,000 people, and it will serve a similar purpose as the Albert Hall; while the side wings will be turned into museums. The wings are connected to the rotunda by buildings of considerable size. A covered piazza or colonnade runs round the wings on both sides and will become a favourite promenade. The main entrance to the building is at the back, or from the Place du Trocadéro.

The gardens will be ornamented by a great variety of fountains and statues by the most eminent French sculptors, and a fine sheet of water will fall in a series of cascades from the base of the rotunda into a large pond underneath, the sloping ground admitting of such a display.

During the exhibition, the Palace of the Trocadéro will be devoted to the illustration of the History of Man. The left wing will be occupied by objects relating to savage and barbarous people from the earliest prehistoric ages to the highest civilization of China and Japan. The right wing will be occupied by objects relating to the civilized races of Europe from their most primitive to their most cultured phases. Between these exhibitions of the art of man in his most savage and in his most civilized states, will be placed the appliances and records of anthropological science, under the direction of M. de Quaterfages. This section will comprise craniology, ethnography, archæology, comparative philology and medical geography. Statistics, models, photographs and apparatus will amply shew forth all that is yet known of this most interesting science.

Several subsidiary exhibitions will be held at the Trocadéro. For instance, there will be in the crypt of the left wing an *exposé* of the sepulchral processes of all nations, a fine collection of Egyptian antiquities, and a display of French costumes. On the border of the river there will be a maritime and fluviatile exhibition; and in the gardens an immense fresh-water aquarium open to the air, and admitting spectators underneath, so that they can look up through the water at the fish swimming overhead.

The objects to be exhibited at the exhibition are classified under the following heads:

1. Works of art.
2. Educational materials and processes connected with the liberal arts.
3. Furniture and its accessories.
4. Textile fabrics, clothing, and its accessories.
5. Chemical industries, raw and manufactured materials.
6. Machinery and processes of mechanical industry.
7. Food products.
8. Agriculture.
9. Pisciculture.

The art section comprises oil and water colour paintings, painting on enamel or porcelain, sculpture, engravings, and architectural drawings. Terra-cotta's, copies of works of art, and unframed pictures are excluded.

Explosives or dangerously inflammable chemicals will be prohibited; alcohol, and hydrocarbons &c., will be received only under certain restrictions. Fuses, matches, fireworks, &c., may be admitted to exhibition in single specimens, or in the form of models.

The machinery in motion is always an attractive feature of such exhibitions, and 1,200 horse-power have been provided for this purpose. The electrical section of the exhibition is expected to be exceptionally extensive and interesting, and arrangements have been made for a series of comparative trials of the electric light.

The agricultural department will comprise all kinds of farm and dairy produce, implements, tools, chemical manures, processes of cultivation, and extermination of pests. A sub-section will be given to arboriculture, timber, and its products; and another to horticulture, including the raising of fruit and flowers, and all the appliances, buildings, and processes connected with it, and a series of special shows will be held fortnightly during the season. A series of trials of agricultural instruments will also be made at intervals during the summer and autumn months.

The piscicultural section will contain live and stuffed specimens of fresh water creatures, mineral waters, geological maps, and models.

Exhibitors will be required to supply clear descriptions of apparatus, accounts of processes, and statistics concerning their exhibits. The awards will be 1,000 gold, 4,000 silver, and 8,000 bronze medals, as well as 8,000 honourable mentions, and 100 grand prizes, and exceptional rewards in silver.

Any exhibitor exhibiting a patentable but as yet unpatented article, may ensure it against piracy by obtaining a certificate from the *prefet* or *sous-prefet* of t *arrondissement* in which the exhibition is held. This letter will give its possessor the same rights as letters patent or registry of design would confer, and dating from the admission of the exhibited article into the exhibition to three months after its closing, without prejudice to the patent which the exhibitor may then take. No person is allowed to copy an exhibit without the consent of the exhibitor. French and foreign exhibitors will pay no rent for space taken up by them, nor for gas, water, and steam required by them; but all expenses of installation, counter-shafting, belting gearing, &c., must be defrayed by them.

A committee of consultation and arbitration has been appointed to revise the arrangements made by the state, and protect the latter against litigation with contractors and exhibitors, and to form a court of judicature in all questions relating to patents, trade marks, &c. The general superintendence of the exhibition is exerted by the French authorities, but special superintendence over each department is exerted by commissioners appointed by the country to which the department belongs. These commissioners are to be distinguished by badges. Active measures to prevent injury to exhibits will be taken by authorities; but the government will not be responsible for damage by fire, &c. All exhibits can, however, be insured. Consignments must be addressed to the care of the special commissioners of the department they are intended for, and marked with the letters E. U. (Exposition Universelle) enclosed in a circle. Goods will be admitted from January 1 to March 30, 1878, with an extension of time, in special cases. They must be completely installed by April 15; and immediately after closing of the exhibition they may be removed. All removing must be finished by December 15, and goods left after that will be kept *en dêpôt*, and if unreclaimed meanwhile, will be sold on June 30, 1879. The authorities will not charge themselves with packing cases, or provide any storage for them, so that exhibitors will have to rely on agencies for the safety of these. The British Commissioners at Westminster have arranged to assist English exhibitors in this matter.

The exhibtion will be opened on May 1, and closed on the last day of October. Exhibitors or their agents will be provided with free passes. The public will be admitted by tickets procurable at postal, omnibus, tram-car, bureaux, and other conspicuous establishments about Paris. Single tickets will cost 1 franc; fortnightly tickets, 10 francs; and season tickets, £4. Suitable catalogues will be provided, and there will be three classes of restaurant to suit different classes of visitors on the grounds.

EXPLOSIVES IN MINES SUPERSEDED.—The colliery of Messrs. Rylands and Sons at Wigan, was the scene a short time ago of an experiment, the results of which promise to effect a vast improvement on the methods at present employed for blasting in mines. Explosives, such as gunpowder or dynamite, are now invariably used for such purposes, with the effect that in "fiery" collieries there is always the risk of disasters like that at the Blantyre Pit, which is attributed to this very cause. It is now proposed to use compressed air in lieu of these dangerous explosives, and a machine invented for the purpose by Mr. Marsh, of Salford, has been tested with very satisfactory results. A "cartridge" or reservoir is placed in a bore or shot-hole, after the manner of a charge of powder, and rammed or plugged in in the same way. This chamber is in connection with a powerful air-pump adapted expressly for the purpose, and by simply turning a wheel the collier can "fire his shot" without the least danger of setting fire to the inflammable gases. Mr. Marsh's machine is capable of exerting a pressure of over 12,000lb. to the square inch, and this force can be produced by two men turning the wheel in less than three minutes from the time of ramming the cartridge. The Wigan experiments show that very large quantities of coal can be brought down at a much smaller expenditure of force. The first "cartridge fired" was burst at a pressure of 7,500lb. to the square inch, the pressure being registered by a ga uge. The coal was fractured but not "brought down," and a second cartridge was inserted and burst at a pressure of 8,250lb. to the square inch, completely

loosening the coal, and breaking up about 8 tons. The whole force of the shot was probably not exerted on the seam, as the ramming was blown out. The machine which is capable of producing such results is described as being very handy and compact and easily used; while the actual costs beyond the first outlay is almost *nil*. The advantages to be found from the adoption of such a system are not exhausted by the removal of all danger of firing the mine. The agitation of the atmosphere caused by the sudden liberation of a large quantity of air on the bursting of the cartridge would improve the ventilation and help to cool the atmosphere of the mine, while the absence of smoke is an important consideration. Attempts have been made to supersede gunpowder as a propulsive agent by the use of in guns steam and compressed air, but they have not met with practical success. Mr. Marsh proposes to apply his new machine to similar purposes as a torpedo, and intends to apply to the Government for permission to make experiments in this direction. Whatever may be the measure of success attending such an application of the invention, its importance in connection with coal mining is undoubted. The experiments carried out under Messrs. Ryland's auspices promise to revolutionise the system of blasting in mines. We referred a short time ago to the probability of introducing the electric light into mines with the adoption of that improvement, and of the use of compressed air instead of gunpowder, together with the abolition of ventilating furnaces in favour of fans or steam jets in the up-cast shaft—means of ventilation which avoid the possibility of igniting the fire-damp in coal mines, and which prevent the possibility of reversing the current and disorganising the ventilation—it would seem that an absolute minimum of danger would be reached. The collier's avocation would at least not be more dangerous than that of the iron miner.—*Globe*.

POLISHING BRASS.—Brass work is best polished by rubbing the surface with rottenstone and sweet oil, then rubbing off with a piece of waste cotton, and polishing with soft leather. A solution of oxalic acid removes the tarnish from brass. The acid must be washed off with water, and the metal rubbed with whiting and soft leather. A mixture of muriatic acid and alum dissolved in water gives a golden colour to brass articles steeped in it for a few seconds.

BRIGHTENING IRON.—The following method of brightening iron which may be suitable for small mechanism, is recommended by Boden. The articles to be brightened are placed for an hour in diluted sulphuric acid, which cleanses them. They are then to be washed with water and dried with sawdust. They are next dipped in commercial nitrous acid for about a second, and at once carefully washed, dried in sawdust, and rubbed clean. It is said that iron goods thus acquire a bright glancing surface, without any of the usual polishing operations. Care should be taken to avoid inhaling the vitrous acid fumes.

THE transit of Mercury on the 6th of May next, will be observed by a scientific expedition specially sent to San Francisco by the French Government. The first observer of a transit of this planet was a Frenchman, Pierre Gassendi, who, in 1631, at Paris, witnessed the passage by means of a camera obscura.

THE departure of the Dutch Arctic expedition has been fixed for May next year. It will consist of a single small vessel of 80 tons, and it is believed that it will be able to escape many dangers from the ice to which a larger vessel would be subject. Already £3,000 have been subscribed to defray expenses, and only £1,000 more is required.

A NEW steamer is being built in India, and fitted out for deep-sea dredging in the Indian seas, thus supplementing the work of the *Challenger* which omitted to dredge in these waters. The first operations will probably be undertaken in the Bay of Bengal. An officer, Lieutenant Jarroid, R.N., is now in England collecting appliances, and the old staff of the *Challenger* are giving the benefit of their experience.

PLATINUM WIRE.—In drawing fine platinum wire for electric fuses, M. Gaiffe found the wire to break repeatedly in the drawing plate before the required fineness was attained. On examining the wire by the microscope, he discovered spots on the wires at the points where they had broken, although before entering the drawing plate the spots could not be seen, and the wire appeared sound in every way. He suspected that they were due to fine particles of dust on the draw plate, which, being forced like wedges into the wire during the process of drawing, weakened it so that it gave way under the pulling strain. He therefore constructed a drawing apparatus from which dust could be excluded, and was thereby enabled to draw very fine wires without accident. He exhibited to the French Academy a specimen of platinum wire one forty-seventh of a millimetre in diameter, and he remarked that with finer plates he believes it possible to draw even much finer wires than that shewn without rupture.

AT a recent meeting of the Academy of Sciences, Vienna, M. Ciamician, in a paper on the "Spectra of the Chemical Elements," arrives at Norman Lockyer's conclusions that the spectra of the first order of elements and of compounds are exclusively bands, that bands are the characteristic spectra of molecules, and lines the characteristic spectra of single atoms. He further concludes that the lines in the spectra of elements chemically allied to each other, correspond either individually or in groups (each group of elements having its characteristic spectrum), and the spectra of the various individuals differing from each other in a change of the position of corresponding or homologous lines. The wave length of the homologous lines correspond to the chemical power of the element—an

element of intenser chemical power giving a greater wave length.

ACCORDING to statements made at the Californian Academy of Science, the *eucalyptus* tree is likely to become serviceable as a fireproof timber. All varieties of it are said to resist fire, and it is proposed to adopt it as a shade and ornament to streets in San Francisco.

SUN'S SPOTS, STORMS, AND FAMINE.—This subject is engaging the attention of its students at present, and some important evidence has been put forth in support of the supposed coincidence between the cyclic appearance of the solar spots, and atmospheric and magnetic disturbances on the earth. That there is such a coincidence has been believed by some for the last twenty years; and the belief is rather a deduction from observation than due to *a priori* reasoning from the nature of the solar spots. It has been gradually gaining ground during this period as fresh evidence has been adduced, and there seems no doubt now about the truth of the agreement. It is now well known that the sun is an incandescent globe of matter, on whose bright surface are visible periodical "spots," uprushes of glowing vapour, and round whose limb are also seen periodical flames of enormous dimensions, called "red prominences." These phenomena, spots, vapour, and flames, periodically wax and wane together, in a cycle of eleven years, that is to say, in every eleven years there is a period of maximum appearance of all three, and a corresponding period of minimum appearance. During a period of maximum, the sun's disc is literally mottled with spots, some of which are visible to the naked eye; while during a period of minimum it is almost entirely spotless. These spots, and their concomitant phenomena, are regarded by Mr. Lockyer and Professor W. W. Hunter "as a rough index of the degree of the sun's energies"; when they are at their maximum the sun displays its maximum energy, and when at their minimum the sun's energy is at its minimum. Dr. Rudolf examined the observations of solar spots made since the year 1750, and found recurring periods of eleven years up to the present time. In 1852, Sabine detected a coincidence between terrestrial magnetic storms, earth currents, as well as auroras, and the solar spots. It is now held by magnetic observers that the curve of magnetic "storms" closely follows the curve representing the frequency of solar spots, and there are grounds for believing that the diurnal variation of the magnetic needle is also dependent on the condition of the sun's surface. In 1867, Mr. Joseph Baxendell was led to infer that the temperature and barometric pressure of the air were also in ratio with the spots; but observations are complicated in this inquiry. The evidence is more reliable and uniform in the case of cyclones, whose close connection with the frequency of spots was first pointed out by Dr. Meldrum, government astronomer at Mauritius. Very recently Mr. Henry Jeula, the statistical secretary at Lloyd's, from an examination of the two cycles from 1855 to 1876 (which, however, is a very narrow basis of data), has found that the percentage of casualties at sea was 15 per cent. greater during the two years of maximum spots in the cycle, than during the two years of minimum spots. In 1871 Mr. Baxendell was led to suspect an increase of rainfall during periods of maximum spots, and it is this inquiry which, owing to the Madras famine, is receiving particular attention just now. India, as a region, is peculiarly well situated for observing the supposed agreement between meteorological and solar phenomena; being a wedge of land jutting into the great equatorial expanse of the southern ocean. Professor Hunter has examined the statistics of rainfall in the presidency of Madras during the last six cycles, that is to say, from the year 1811 to 1877. During this period the years of minimum sun-spots were 1810, 1823, 1832, 1853, 1865, 1876. Now famine in Madras is caused by deficiency of rainfall, due to deficiency of moisture in the summer monsoon from the south-west, or the winter monsoon from the north-east. Strikingly enough the years of marked famine, by failure of crops, in Madras during the same period are 1811, 1824, 1833, 1854, 1866, 1877, or the year after the minimum spot year every time. Professor Hunter deduces from five cycles that during minimum sun-spot years the north-east monsoon brought about 40 per cent., and the south-west monsoon about 26 per cent. less rain to Madras than during ordinary years of spots. Observations made on the rainfall appear also to support the theory; but it seems from similar observations on European and North American rainfall, that in receding from the equator to more northerly latitudes, the uniformity of evidence shades off, and cannot be said to be for or against the theory.

EXPLOSIONS IN MINES.—M. Bassin proposes to prevent explosions by watering the galleries of dry mines, ventilating and blasting by compressed air, and enclosing the lamp flame in Bastie's toughened glass, rather than in the ordinary wire gauze: the vent for the flame being, however, covered with several layers of gauze.

CAOUTCHOUC.—In June, 1876, the English Government sent out 90,000 seeds of the Brazilian rubber tree to India, but only 2,500 arrived there in good condition. These were sown together in a plot, and in a few days had put forth shoots eighteen inches high. A number of the best plants have been sent to Ceylon, Singapore, and Burmah, for transplantation at these places.

PROPAGATION OF WAVES IN A GASEOUS MEDIUM.—Mr. S. Tolver Preston has shown how the known laws of the propagation of sound in a gas can be easily and simply deduced from the hypothesis that the particles of the gas immediately in contact with the vibrating surface take increments of velocity therefrom, and

communicate them to neighbouring particles with a velocity of propagation in simple ratio to the mean velocity of the particles themselves. For instance, the mean velocity of the particles of hydrogen is known, by the kinetic theory, to be four times greater than the mean velocity of the particles of air, and hence it is, according to Mr. Preston's hypothesis, that sound travels four times quicker in hydrogen than in air. For hydrogen at 0° Centigrade the ratio of the velocity of propagation of impulses or waves to the mean velocity of the particles (as deduced from the velocity of sound waves and the mean velocity of the particles according to the kinetic theory) is 0·688; that is to say, sound waves are propagated in hydrogen at a velocity 0·688 of the mean velocity of their particles. By the kinetic theory, Clerk Maxwell calculates that this ratio ought to be 0·745, supposing the molecules to be spherical and infinitely small as compared to their mean distances apart.

GRAPHIC PHONETICS.—The researches of MM. Marey and Rosapelly, which promise to lead to a new system of graphic phonetics useful in the teaching of deaf mutes to articulate, were undertaken at the request of the French Linguistical Society in 1875. It is well known that in speech the larynx emits the fundamental note, or vowel sound, and that this is shaped, so to speak, by the movements of the lips and palate, and acquires its peculiar timbre from the resonating cavities of the pharynx, nasal fossæ, and cheeks. By means of several ingenious contrivances MM. Marey, Rosapelly, and Czermack, are able to record the vibrations of the larynx in uttering the vowel sounds, the movements of the lips in defining them, and the movements of the palate (or rather the nasal pressure produced by them) in determining the voice consonants *m n*. These separate graphic representations of vowel vibration and consonant definition, placed side by side, furnish a means of enabling articulation to be learned by sight. It is also supposed that they may throw light on the laws governing the evolution of language.

Patents.

2997. "Batteries specially useful for medical purposes."—J. and S. J. COXETER, August 7.

3034. "Improvements in and appertaining to electric signalling apparatus on railways."—W. P. THOMPSON (communicated by C. Lecoq), August 9.

3050. "Receiving instruments and relays for electric telegraph."—R. W. H. P. HIGGS, August 10.

3139. "Improvements in the receiving instruments of electric telegraphs and in recorders for other uses."—J. MUIRHEAD and A. MUIRHEAD, August 17.

3161. "Apparatus for steering or directing ships or vessels (automatic electric manipulator)."—J. C. MEWBURN (communicated by J. Caselli), August 20.

3170. "An automatical kindler for electric lights."—L. DENAYROUZE, August 21.

3187. "A magneto-dynamo-electric machine."—P. JABLOCHKOFF, August 22.

3404. "Improvements in and connected with door-locks for opening same electrically or pneumatically."—G. W. VON NAUROCKI (communicated by A. Leinke), September 7.

3469. "Apparatus or appliances connected with generating, conducting, measuring, or testing, and applying electricity."—J. S. PULVERMACHER, September 14.

3487. "Electric telegraph apparatus."—L. A. BRASSEUR and S. W. M. DE SUSSEX, September 15.

3549. "Improvements in an instrument and apparatus known as the telephone."—T. W. MANN (communicated by J. A. Briggs), September 21.

3552. "Improvements in the construction and arrangement of magneto-electric apparatus and the application of the same to signalling and other purposes."—A. S. HICKLEY, September 21.

3597. "Electric telegraphs."—F. H. W. Higgins, September 25.

3639. "Electric telegraph apparatus.—L. A. BRASSEUR and S. W. M. DE SUSSEX.

3726. "An improved duplex telegraphic printing apparatus."—G. L. J. VANDER PLOEG, October 8.

3743. "Magneto-electric machine."—J. H. JOHNSON (communicated by J. Miot), October 9.

3750. "An improved electro-magnetic hydraulic engine.—W. R. LAKE (communicated by H. C. Atwood), October 9.

3822. "Electric telephony and telegraphy."—D. D. REDMOND, October 16.

3839. "A new system of distributing and increasing with atmospheric electric currents proceeding from a single source of electricity for the purpose of supplying several lighting centres."—J. JABLOCHKOFF, October 17.

3854. "An improved expansion and contraction coupling for signal and telegraph wires.—G. PICKERSGILL, October 18.

3906.—Improved electrical apparatus for indicating the existence of injuries or defects in roofs, bridges, and other structures."—F. BARBER (communicated by J. Forbes), October 22.

3981. "Improvements in electro-magnets and in magnetic motor engines."—M. H. SMITH, October 27.

4036. "Electrical apparatus for application to railway brakes."—H. A. DIBBIN, October 31.

4053. "Improvements in electro-metallurgy, and in apparatus connected therewith."—H. CONRADI (communicated by E. André), November 1.

4059. "Improvements in or connected with circuit closers for electrical alarms."—B. HUNT (communicated by S. S. Applegate), November 1.

4133. "Means or apparatus for regulating the speed of clockwork for telegraphic and other purposes."—J. M. A. STROH, November 6.

4232. "An improved magnetic apparatus for ringing bells, operating telegraphic and other signals, and for similar purposes."—G. ZANNI, November 13.

4321. An improved system of a double telegraphic transmission."—J. X. E. GIEUR, November 19.

4341. "Improvements in the method of applying, and in the arrangement of, the conducting wires conveying electricity to be used in sending telephonic messages."—A. G. BELL, November 20.

4402. "Apparatus for the transmission of sounds by electricity through wires or other conductors."—J. A. EWING and F. JENKIN, November 22.